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ABSTRACT

FACTORS INFLUENCING HEMISPHERIC SPECIALIZATION

Brenda Joyce Royster

To determine whether hemispheric specialization for visuospatial functions occurs as predicted from existing models of cerebral lateralization processes, 16 participants were bilaterally presented face stimuli using a tachistoscope. Both familiar and unfamiliar faces were utilized with a memory and nonmemory condition for each. Subjects made judgements of "same" when faces were identical to each other and "different" when faces were of different persons. As predicted, the reaction times to the unfamiliar memorized faces were significantly faster when the stimuli were presented to the left visual field/right hemisphere. Reaction times to the unfamiliar faces also showed a left visual field/right hemisphere advantage for judgements of different but not for judgements of same. No visual-field differences were found using familiar stimuli for either memory condition or judgement type, indicating that different processes may underlie the analysis of the two stimulus types in addition to the two judgement types.

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FACTORS INFLUENCING HEMISPHERIC SPECIALIZATION

By

Brenda Joyce Royster

B.S., Temple University, 1974

A Thesis submitted to the Department of Psychology
College of Arts and Sciences
The University of West Florida
In partial fulfillment of the requirements for the degree of
Master of Arts

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The thesis of Brenda Joyce Royster is approved

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ABSTRACT

FACTORS INFLUENCING HEMISPHERIC SPECIALIZATION

Brenda Joyce Royster

To determine whether hemispheric specialization for visuospatial functions occurs as predicted from existing models of cerebral lateralization processes, 16 participants were bilaterally presented face stimuli using a tachistoscope. Both familiar and unfamiliar faces were utilized with a memory and nonmemory condition for each. Subjects made judgements of "same" when faces were identical to each other and "different" when faces were of different persons. As predicted, the reaction times to the unfamiliar memorized faces were significantly faster when the stimuli were presented to the left visual field/right hemisphere. Reaction times to the unfamiliar faces also showed a left visual field/right hemisphere advantage for judgements of different but not for judgements of same. No visual-field differences were found using familiar stimuli for either memory condition or judgement type, indicating that different processes may underlie the analysis of the two stimulus types in addition to the two judgement types.

FACTORS INFLUENCING HEMISPHERIC SPECIALIZATION

The research concerning the functions of the cerebral hemispheres of the brain indicates that the right hemisphere (RH) is specialized for visuospatial processing while the left hemisphere (LH) is specialized for verbal or logical information processing (Geffen, Bradshaw, & Wallace, 1971; Moscovitch, Scullion, & Christie, 1976; Strauss & Moscovitch, 1981). Right hemisphere specialization for visual material has been shown frequently with faces (Leehey, Carey, Diamond, & Cahn, 1978; Rizzolatti & Buchtel, 1977; Rizzolatti, Umilta, & Berlucchi, 1971) and with discrete arrays (Bradshaw, Gates, & Patterson, 1975).

Functional asymmetry of the brain's hemispheres is also reflected in the performance of patients exhibiting damage to the temporal and parietal lobes of the RH. Warrington and James (1967) have reported face recognition impairments in patients with RH damage but not with patients having LH damage. Yin (1970) also reported similar findings.

However, not all studies find the RH to be responsible for superior face recognition (Ellis & Shepherd, 1975; Marzi & Berlucchi, 1977). Furthermore, studies using other types of spatial stimuli report no differences between either hemisphere (Hardyck, Tzeng, & Wang, 1978). Given these observed differences in results, the present research proposes a systematic investigation designed to clarify several ambiguities in the field. The studies to be reviewed are primarily limited to those employing faces as visuospatial stimuli.

The impetus for this research was suggested by a study conducted by Hardyck et al. (1978) who found that different experimental procedures appeared to moderate the results. Hardyck et al. state that the presence or absence of hemispheric differences are systematically associated with the type of experimental contexts employed. When studies have used a limited number of simple stimuli repeatedly for many trials, the typical hemispheric differences are found. In contrast, the few published studies whose experimental procedures used new information on each trial have found no hemispheric function differences. In order to systematically examine the effects of hemispheric lateralization on cognitive processing, Hardyck et al. conducted a series of experiments using Chinese characters as visuospatial stimuli and their English equivalents as verbal stimuli.

The stimuli for their first experiment were 96 words in Chinese and their English translations. Using fluent Chinese-English bilinguals as subjects, 32 pairs of Chinese-English stimuli were presented tachistoscopically to the left visual field/right hemisphere (LVF-RH), right visual field/left hemisphere (RVF-LH), and simultaneously to both visual fields. The eight participants responded "yes" if the pair had the same meaning and "no" if they did not. The second experiment used the same materials and procedure but the dependent variable measure was reaction-time. Results for both experiments showed no visual-hemisphere differences, suggesting that the processing of new information is not a highly lateralized process.

To examine the experimental design with a small number of stimuli over many trials, Hardyck et al. used only eight stimulus pairs shown in the RVF-LH and LVF-RH for 200 trials. Nine subjects with no knowledge of Chinese viewed Chinese-Chinese (CC), English-English (EE), and Chinese-English (CE) pairs and were asked to indicate "same" or "different" by pressing a button for reaction-time. Analysis of the mean values showed a RVF-LH superiority for EE stimuli and a LVF-RH effect for CC stimuli. In addition, reaction times by hemisphere effects increased over trials.

Hardyck et al. interpreted these results as reflecting differences in storage locations rather than differences in cognitive processing in specialized hemispheres. When stimuli are repeated over many trials, "... a change in processing strategy seems to take place, with the subject responding by a process that is better described as referencing a table of known values ..." (pp. 68). Therefore, if their results generalize for face recognition, RH storage should only occur when the faces are <u>memorized</u>

or highly familiar. Since no storage supposedly takes place when new information is introduced in each trial, both hemispheres should be equally competent at recognizing faces when new faces are presented on each trial.

Ellis and Shepherd (1975) conducted such a study using eight right-handed subjects. The stimuli were 36 female photographs with 18 stimuli each presented tachistoscopically to the LVF-RH and RVF-LH. On half of the trials the stimulus face was followed by an identical one, for the remainder, the second face was different. Subjects verbally responded "same" if both faces were identical, and "different" if faces did not match one another. A second variation inverted the faces to test Yin's (1970) hypothesis that the RH is specialized for visuospatial patterns in general. The results showed no evidence of interaction between field of presentation and face orientation and thus are consistent with the Hardyck et al. (1978) hypothesis.

However, since Ellis and Shepherd (1975) used an exposure duration of only 15 msec, it is unknown whether the participants actually viewed the stimuli as faces. It had been suggested by Leehey et al. (1978) that the 15 msec exposure was insufficient to allow enough depth of processing to occur (Craik & Lockhart, 1972). The present experiment will test the Hardyck et al. hypothesis using new stimulus material on each trial. However, the exposure duration will ensure the stimuli are viewed as faces.

Rizzolatti, Umilta, and Berlucchi (1971) conducted a study showing an experimental method and findings which also could be consistent with the hypothesis of Hardyck et al. (1978). During the face discrimination task, 12 subjects viewed four faces (two with positive and two with negative expressions) that appeared 41 times over 164 trials for each of four sessions. The stimuli were projected on a screen for 100 msec and the participants were instructed to press a key at the appearance of positive stimuli. Because Rizzolatti et al. used a small number of stimuli over a great number of trials, the obtained results showed the presence of a LVF-RH superiority for the speed of response to faces. This result again is congruent with Hardyck et al.

Jeffen, Bradshaw, and Wallace (1971) also obtained a LVF-RH superiority using reaction times when five faces were tachistoscopically presented for 80 trials. Participants memorized one face ten minutes before the start of the experiment. As a reminder, the memory face was projected in the center of the field for 1 sec followed by one of the five test faces presented either to the left or right of fixation for 160 msec. Participants made judgements of "same" or "different" by pressing one of two response buttons. These findings are consistent with the Hardyck et al. hypothesis since the experimental method included a small number of stimuli over a great number of trials and the typical LVF-RH storage occurred for the faces that were memorized throughout the experiment.

The difference between experimental procedures that repeatedly use few stimuli and one that uses new stimuli on each trial appears to be the resulting LVF-RH storage of the faces that had been memorized during the course of the experiment. The present experimental design will include a memory factor not through the use of repetitive stimuli, but by designating faces to be memorized by the participants before the start of the experiment. If the reaction times for memorized face stimuli indicate the emergence of lateralization of hemisphere function, then these findings will be consistent with the storage hypothesis of Hardyck et al. (1978).

Rizzolatti and Buchtel (1977) conducted a reaction time experiment with face recognition to test their hypothesis that cognitive processes may be more lateralized in men than in women. Eight males and eight females learned to recognize black and white photographs of four faces (two with positive and two with negative facial expressions). Faces were projected on a tangent screen either to the LVF-RH or RVF-LH and participants responded by pressing a key only when two of the faces were positive faces. Participants were given four blocks of 40 trials for a total of 160 trials. Means for each subject were averaged across sessions, and data analysis showed that males consistently showed significantly faster reaction times to face stimuli presented in the LVF-RH. Females showed no such lateralization, with stimuli presented to both the LVF-RH and RVF-LH being recognized equally well. Since the female participants showed no lateralization of hemisphere functioning, these findings are not in complete support of the Hardyck et al. hypothesis that LVF-RH storage should occur when stimuli are repeated over many trials. However, the gender differences have not been consistent. Patterson and Bradshaw (1975) and Bradshaw, Gates, and Patterson (1976) have not found sex differences in hemispheric processing when visuospatial stimuli were used. It is interesting to note that Patterson et al. did find that faces presented in the LVF-RH were responded to significantly faster than faces presented in the RVF-LH when a total of four faces were used in two blocks of 64 trials. Bradshaw et al. assessed hemispheric processing of visuospatial material using discrete arrays of circles, squares, and triangles; therefore, no direct comparison can be made using the Hardyck et al. hypothesis. The present experiment will further investigate sex differences under varying experimental conditions (i.e., the effects of repetition of stimuli over many trials versus the effects of stimuli shown only once) to determine the extent to which cognitive mechanisms are lateralized in males and females.

In 1977, Marzi and Berlucchi conducted an experiment producing results at variance with the hypothesis of Hardyck et al. Because famous faces were used as stimuli (the faces were well-known to the participants and presumably in storage), this experimental procedure can be equated, and therefore compared to, procedures using repetitious stimuli.

Marzi and Berlucchi used 32 right-handed males and projected 80 different slides of famous faces onto a screen. Forty slides were projected to the LVF-RH and RVF-LH for 400 msec, and the participants identified each face by verbally stating its proper name. After the presentations in the two visual fields, the participants were shown the same 80 slides in central vision for recognition. Marzi and Berlucchi's results showed a RVF-LH superiority using famous faces that were highly familiar to the participants. These results contrast with Heffen et al. (1971) who had subjects memorize unfamiliar faces producing a LVF-RH superiority.

Since Marzi and Berlucchi's famous faces were not stored in the predicted RH, the study suggests that both hemispheres store faces, but differ in the type of face that is stored (familiar versus unfamiliar). When the memorized face is unfamiliar, RH storage occurs and when the memorized face is familiar, LH storage results. Since the type of stimulus, familiar and unfamiliar, seem to moderate where storage occurs, the present experiment will provide two types of stimulus materials: familiar material using famous faces and unfamiliar material using faces unknown to the participants.

Although the above research appears to be rather disparate, there are enough regularities to suggest several hypotheses:

(1) If the cognitive processes of males are more lateralized than females, then the reaction times for males should be

shorter and show more visual-field dominance (Rizzolatti et al., 1977).

(2) Since the faces in the memory condition for familiar and unfamiliar types of stimulus materials were memorized before the start of the experiment, the reaction times should be shorter than those for the nonmemory condition where no stimulus was shown more than once.

(3) Judgements of same should yield statistically faster reaction times than judgements of different (Bradshaw et al., 1976; Hardyck et al., 1978).

(4) It is expected that for unfamiliar faces, none of which are specifically memorized, reaction times will indicate both hemispheres equally competent at the task (Ellis et al., 1975; Hardyck et al., 1978).

(5) For target faces that are memorized but are unfamiliar to the participants, a LVF-RH superiority should emerge as a result of storage (Geffen et al., 1971; Rizzolatti et al., 1971).

(6) If type of stimulus material makes a difference, then familiar face stimuli should yield an overall RVF-LH superiority with shorter reaction times for memorized faces than for nonmemorized familiar faces (Marzi et al., 1977). No one has yet systematically investigated each of these hypotheses in the same experimental design. In order to clarify the literature, the present study was designed to test each of them.

METHOD

Subjects

Sixteen volunteers, eight male and eight female University of West Florida students with a mean age of 29.4 (*SD* = 10.7), were each paid $5 to participate in the experiment. All participants were first screened for handedness and visual acuity. Only those persons assessed as strongly right-handed on the basis of a questionnaire (Sherman & Kulhavey, 1976), and whose parents and siblings were not classified as left-handed or ambidextrous, were selected to participate in the experiment. Participants also had corrected or uncorrected vision that was at least 20/20 as determined by a Snellen eye chart test.

Apparatus

Stimuli were unilaterally presented using a Scientific Prototype 2-channel tachistoscope (model 220C) and the latency from onset of the test stimulus was recorded to the nearest millisecond. A response panel consisting of two buttons, located at the midline of the participant, stopped the timer so that the response times and judgements could be recorded for each trial.

Figure 1. Examples of stimulus combinations appearing in the eight test conditions: (1) familiar target faces for judgements of same, (2) familiar target faces for judgements of different, (3) familiar nonmemory faces for judgements of same, (4) familiar nonmemory faces for judgements of different, (5) unfamiliar target faces for judgements of same, (6) unfamiliar target faces for judgements of different, (7) unfamiliar nonmemory faces for judgements of same, and (8) unfamiliar nonmemory faces for judgements of different.

Materials

Figure 1 shows examples of stimulus combinations for each of the eight test conditions. Each test condition included 10 pairs of faces for a total of 80 stimuli: 40 for the familiar stimulus materials and 40 for the unfamiliar stimuli. Within each of the familiar and unfamiliar types of stimulus materials, there were 20 pairs of faces for a memory condition and 20 pairs of faces for a nonmemory condition. Each of the 20 pairs of faces in both the memory and nonmemory conditions was composed of 10 judgements of same and 10 judgements of different with five pairs of faces being shown in the LVF-RH and RVF-LH for each judgement type.

Seventy different pictures were used to develop the above stimuli: 35 for the familiar and 35 for the unfamiliar stimuli. Within the memory condition, five pictures of famous persons (familiar stimuli) and five pictures of unknown persons (unfamiliar stimuli) were used in varying combinations to produce five pairs of faces requiring judgements of same and five pairs requiring judgements of different for each LVF and RVF condition. Within the nonmemory condition for the familiar and unfamiliar stimuli, 30 pictures of famous and unknown persons were used to produce five judgements of same and five judgements of different for each visual-field condition. For judgements of same, 10 different pictures were required: five presented in the LVF and five presented in the RVF. For judgements of different, 20 different pictures were required: 10 presented in the LVF and 10 presented in the RVF.

All of the faces in the familiar condition were comprised of famous persons who either currently hold prominent positions and are featured in the daily news media, or hold popular reputations due to their acting abilities and frequent appearances in the television or motion picture medias. All of the faces in the unfamiliar condition were similar with respect to general age, expression, and lack of outstanding features, such as glasses, unique marks, mustaches, or beards.

The faces were actual black and white photographs of equal numbers of male and female faces. All pictures in all conditions were similar and included the face and hair. They were, however, trimmed at the neck to eliminate clothing variations as distinguishing characteristics. The picture size for all face stimuli was 2.50 cm X 3 cm. For judgements of same, the pictures were of the same person in all cases; however, one of the pair was a reverse image of the other. For judgements of different, the pictures were of different persons and different poses.

Each stimulus was placed on 12.5 cm X 10 cm cards and consisted of two faces, one above the other. They were counterbalanced in terms of top and bottom locations and were placed either in the LVF or RVF. All stimuli extended 2.25 cm to the left or right of fixation, thereby subtending a visual angle of 3.27 degrees from fixation to the geometric center of the stimuli. Pairs of photographs in the RVF and LVF were set 45 degrees of vertical visual angle above and below the central fixation point.

Procedure

Each participant received 40 trials both in the familiar and unfamiliar type of stimulus condition for both memory and nonmemory conditions. This resulted in 80 trials for each subject. In the memory condition, participants were given five faces (either familiar or unfamiliar) to study for five minutes before the actual testing began. To insure that the faces were committed to memory, the participants were asked to point to the memory faces that were present among five arrays of nine faces. If the participant failed to identify any of the five memory faces from the arrays, an additional five minutes were given to restudy the pictures and the practice trials using the arrays were administered again. Participants also received 10 practice trials using the memory faces to familiarize them with the procedure that was used in the actual experiment. The pairs of test faces were presented to the LVF-RH or RVF-LH, and the participants' task was to make a judgement "same" if both faces were the same, or "different" if both faces were different from each other. The participants were informed that they would be shown famous faces when assigned to the familiar type of stimulus condition, and faces that were unknown to them when assigned to the unfamiliar type of stimulus condition. Half of the male and female participants received the familiar stimuli first and half received the unfamiliar type of stimuli first.

Each trial began with the participant viewing a pre-exposure field consisting of a 12.75 cm X 10 cm card with a black fixation point at its center. Prior to each trial, the experimenter said, "Fixate" to alert the participant to fixate the center space and press both response buttons in preparation for a stimulus card. The stimulus card was flashed for 150 msec either to the left or right of fixation, and was followed immediately by the return of the pre-exposure field. Onset of the stimulus triggered an electronic timer which stopped when the participant released both buttons located at his or her midline. All participants were instructed to release both buttons when they had decided which judgement to make. To avoid the problem of one hand or hemisphere leading, participants released both buttons simultaneously with the thumb of each hand. The participants were then instructed to state verbally their judgement of "same" or "different". If the participant made an error on any trial, the trial was not included in the data analysis. There were 40 trials in each of the familiar and unfamiliar conditions in which memory and nonmemory items were presented in a pseudo-random order with equal numbers of stimuli for visual field of presentation and for type of judgement.

The stimuli for the nonmemory items in the familiar and unfamiliar conditions were balanced and no picture, or stimulus pair, was shown more than once. The stimuli for visual-field was balanced so that stimuli originally seen in the LVF or RVF were viewed in the opposite visual-field for half of the participants. The stimulus pairs for the memory items were shown only once in each visual-field condition.

RESULTS AND DISCUSSION

There were six comparisons that were of interest following the literature review. In order to determine which test means differed from one another, Orthogonal tests using F Ratio (Kirk, 1968) were used at $p = .05$ level of significance.

Sex Differences

Since the results of studies employing sex as a variable have led to conflicting results (Bradshaw et al., 1977; Patterson & Bradshaw, 1975; Rizzolatti & Buchtel, 1977), it is interesting to note that in this experiment no differences were found between males (*M* = .565 and *SD* = .019) and females (*M* = .561 and *SD* = .015).

Memory Differences

Comparison of the reaction times for the memory and nonmemory conditions within each of the types of stimulus conditions showed no statistical differences. For the familiar type of stimuli, the memory condition showed a mean of .557 (*SD* = .016) and the nonmemory condition yielded a mean of .571 (*SD* = .001). For the unfamiliar stimuli, the memory condition yielded a mean of .552 (*SD* = .015) and the nonmemory condition a mean of .572 (*SD* = .011).

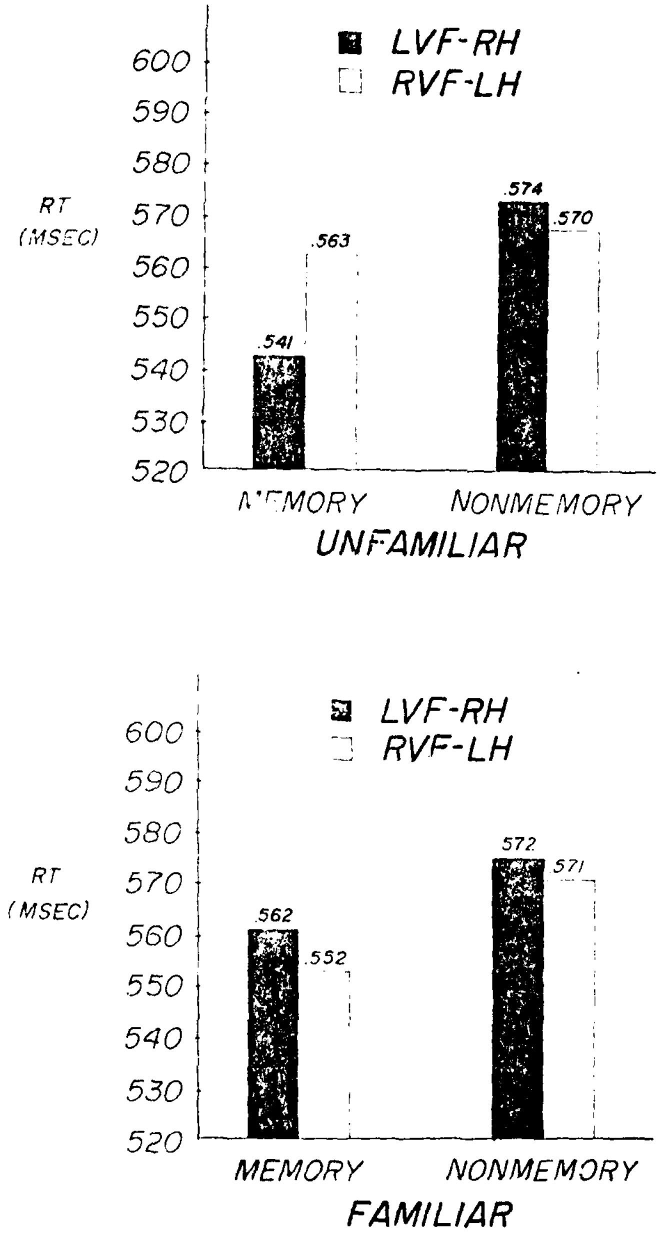

Figure 2. Mean reaction times across subjects as a function of memory conditions, visual-field, and stimulus familiarity.

These findings were unexpected since the faces in the memory condition for each of the familiar and unfamiliar types of stimulus materials had been memorized by the participants before the start of the experiment.

Judgement Differences

It was thought that judgements of "same" would yield statistically faster reaction times than judgements of "different" (Bradshaw et al., 1976; Hardyck et al., 1978; Moscovitch et al., 1976); however, the results showed no differences between judgements of "same" (M = .558 and SD = .012) and judgements of "different" (M = .560 and SD = .016).

Unfamiliar Material and Visual-Field Effects

The next comparisons involved the prediction that for the unfamiliar type of stimuli a LVF-RH superiority would emerge as a result of the memory requirement. Also hypothesized was that the reaction times for the unfamiliar faces in the nonmemory condition would show either visual-field-hemisphere competent. Figure 2 shows that this is precisely what occurred.

For the nonmemory condition in the unfamiliar type of stimuli, both the LVF-RH (M = .574 and SD = .011) and the RVF-LH (M = .570 and SD = .014) were equally adept at processing the stimuli. Also, the RVF-LH for both the memory condition (M = .563 and SD = .011) and nonmemory condition (M = .570 and SD = .014) showed no differences. However, when the unfamiliar stimulus material contained a memory factor, the LVF-RH (M = .541 and SD = .009) shows significantly faster reaction times than the LVF-RH for the nonmemory condition, t (14) = 2.27, p .01. Therefore, the memorized or target items were handled significantly faster in the LVF-RH than the nonmemory items which were shown only once in the same visual field.

Familiar Material and Visual-Field Effects

For the last comparison involving the familiar type of stimuli, the hypothesis stated that a RVF-LH superiority should emerge for both the memory and nonmemory conditions. However, figure 2 shows that no differences were found between the LVF-RH (M = .562 and SD = .024) and the RVF-LH (M = .552 and SD = .009) for the memory condition. For the nonmemory condition in the familiar type of stimulus material, the LVF-RH (M = .572 and SD = .010) is almost equal to the RVF-LH (M = .571 and SD = .014).

Analysis of Variance

A five-way analysis of variance (BMD P2V) was performed on the mean reaction times for each subject (sex, type of stimulus material, memory condition, visual-field condition, and type of judgement), with repeated measures on the last four factors. Since several analyses have already been performed on the data, the reader is cautioned that the ANOVA is intended for use as a descriptive tool rather than for purposes of generalization.

The five-way ANOVA indicated that the only main effect to reach significance was the memory condition, F (1,14) = 9.94, p = .007, with the mean for the overall memory

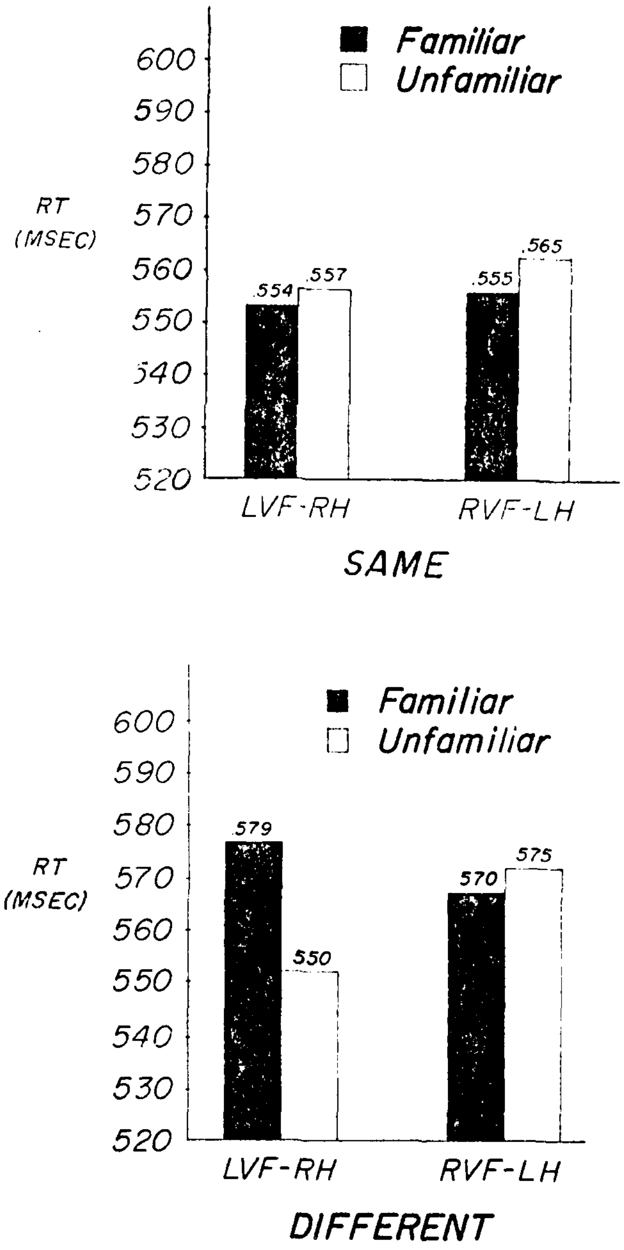

Figure 3. Mean reaction times across subjects as a function of stimulus familiarity, visual-field, and type of judgement.

condition (.555) being greater than the mean for the nonmemory condition (.572). Of the interaction effects, the only one to reach acceptable levels of significance was type of stimulus material X visual-field X type of judgement, $\underline{F}$ (1,14) = 10.49, $\underline{p}$ = .006. Figure 3 shows that for judgements of "same", both the LVF-RH and RVF-LH processed the familiar and unfamiliar stimulus material equally well, with tests for Least Significant Difference (Kirk, 1968) indicating no significant differences between them. However, for judgements of "different", the LVF-RH (.550) processed the unfamiliar stimuli significantly faster than it did the familiar type of stimulus material. Tests for simple effects also revealed that the unfamiliar stimuli were processed significantly faster in the LVF-RH (.550) than in the RVF-LH (.575) for judgements of "different". It appears that for judgements of "different", type of stimulus material may make a difference: The LVF-RH did better at processing the unfamiliar material than the familiar material, while the RVF-LH appeared to process both equally well.

Errors were present in 4.84% of the total number of trials. Chi-Square analysis indicated that error rates for memory and nonmemory conditions for both familiar and unfamiliar types of stimuli were evenly distributed across visual fields.

CONCLUSIONS

A Priori Comparisons

As reported earlier, studies using unfamiliar stimuli either possessed a memory condition where a small number of faces were repeated over many trials, or a nonmemory condition where no repetition of the stimuli occurred (Hardyck et al., 1978). Thus, a hypothesis was formulated stating that a condition using unfamiliar stimuli with a memory requirement would yield a LVF-RH superiority and that the unfamiliar stimuli without any repetition of stimuli would be processed equally well by both hemispheres. As predicted, the results did indeed show these differences and do support the hypothesis of Hardyck et al.

Hardyck et al. (1978) interpret these results as reflecting differences in storage locations rather than differences in cognitive processing in specialized hemispheres. When a memory factor is introduced, the stimuli (if they are unfamiliar) are stored in the RH and are referenced as it is needed. However, if new stimuli are introduced on each trial, no storage occurs and either hemisphere processes the material.

The levels of processing theory offer another way of explaining these results. When the stimulus is unfamiliar, contains no meaningful material, and is shown once with no repetition, it is viewed in terms of brightness and contrast and processed very superficially along the continuum. Because the face matches hold no meaning, and no opportunity is given to attach any meaning (nonmemory condition), either hemisphere can handle these simple face comparisons. However, when subjects are exposed to the same stimuli repeatedly, a stable representation is generated in memory. As a result, the stimuli are processed deeper along the continuum and a LVF-RH superiority emerges (Moscovitch et al., 1976).

Unfortunately, neither the hypothesis of Hardyck et al. (1978) nor the levels of processing theory (Moscovitch et al., 1976) can explain the results obtained for the familiar type of stimulus material. To maintain consistency with these latter studies, the results should have shown a hemisphere superiority (either left or right) for the stimuli in the memory condition. Moscovitch et al. (1976) used famous faces (the Beatles) for stimuli and attained a LVF-RH advantage for their processing. Marzi and Berlucchi's (1977) results show a RVF-LH superiority for their famous faces.

There are several possible explanations as to why no visual field differences were found with the familiar stimuli. In the Marzi and Berlucchi (1977) study, each stimulus was presented for 400 msec to either the LVF-RH or RVF-LH and verbal recognition was required at that time. After the presentations, each subject was again shown the same faces in central vision for prolonged inspection and recognition. Moscovitch et al. (1976) used an exposure duration of 300 msec for their famous faces. The stimuli used in the present experiment were shown for 150 msec and verbal recognition was not required. Perhaps more time is required for the analytical processing of facial features, a strategy which Patterson and Bradshaw (1975) hypothesize leads to a RVF-LH superiority. Perhaps verbal representation of familiar stimuli is necessary before a RVF-LH superiority occurs (Levy, Trevarthen, & Sperry, 1972). At any rate, studies employing famous faces are few and no pattern is distinguishable from reviewing such a limited number of studies.

Post Hoc Testing

The difference between the judgements of same and different are very interesting; however, the reader is again cautioned concerning the exploratory nature of the ANOVA post hoc tests. Moscovitch et al. (1976) propose that different processes may underlie same and different judgements. In the Moscovitch et al. study, photographs and caricatures for each of the Beatles were projected to either visual field composing a homogenous response condition and a mixed response condition. Results showed a LVF-RH superiority for the mixed response condition only. These results were interpreted as partial support for the idea that homogenous responses are handled at a different, lower-level analysis which either hemisphere can handle. The mixed responses generated a stable memory trace which is present at the later stages of the information processing continuum, where the specialized functions of the cerebral hemispheres supposedly operate (Moscovitch et al., 1976). It would be interesting to determine if hemisphere asymmetry emerges for difficult decisions but not for simple matches with the use of verbal stimuli. If lateralization occurs for the more difficult matches, then the specialized functions of the cerebral hemispheres operate only when the successful completion of a complex task is required.

The levels of processing theory can explain why a perceptual asymmetry was found for judgements of "different" for unfamiliar stimulus material. However, why did no hemisphere superiority emerge in the familiar stimulus condition for judgements of "different"? Certainly a stable memory trace was formed for these faces which were presumably already in storage and reinforced by the additional memory requirement. The difficulty in explaining these results are only confounded when one attempts to review studies employing judgements of "same" and "different".

Variable and conflicting results are shown for the judgements of same and different. Bradshaw et al. (1976) have reported a LVF-RH superiority for judgements of "different" but not for judgements of "same" when two elements in an array matched and one differed. Patterson and Bradshaw (1975) found a LVF-RH superiority for judgements of same and a RVF-LH superiority for judgements of "different" for the processing of pairs of schematic faces. Geffen, Bradshaw, and Wallace (1971) found no differences between "same" and "different" responses indicating that the LVF-RH superiority was maintained for both types of judgements.

Since no other study has employed both familiar and unfamiliar stimuli under memory and nonmemory conditions, there are no findings in which to compare the present results. Literature employing famous faces as stimuli are also few in number. At any rate, there appears to be a difference between familiar and unfamiliar type of stimulus materials and where the processing and storage occurs for each. There are also differences (at least for unfamiliar stimuli) between memory and nonmemory conditions where the memory factor is crucial for the emergence of lateralization effects. Of equal importance are the judgements of "same" and "different" which have yielded consistently dissimilar results throughout the literature.

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